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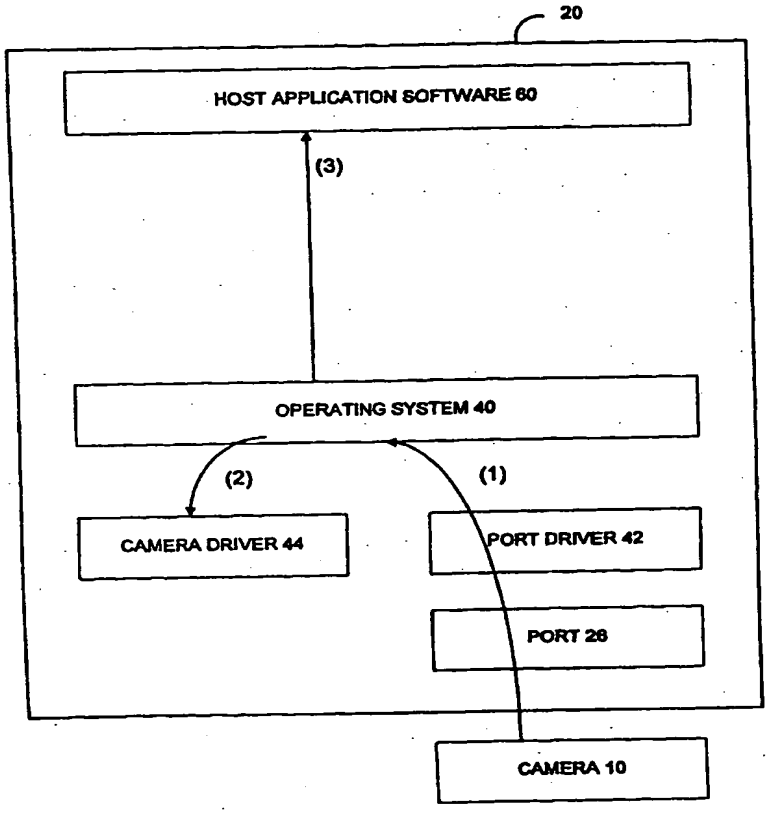
(54) Title: AUTOMATIC UPDATE OF CAMERA FIRMWARE

(57) Abstract

A method of updating firmware between an imaging device (10) and a host system (20) is disclosed. The host system detects that the firmware on the imaging device is incompatible with a configuration of the host system. In response to detecting the incompatibility, an updated firmware image is transferred from the host system to the imaging device.



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AUTOMATIC UPDATE OF CAMERA FIRMWARE

FIELD OF THE INVENTION

The present invention relates to the field of imaging. More particularly, this invention relates to updating firmware between an imaging device and a host system.

BACKGROUND OF THE INVENTION

Imaging devices, such as cameras, typically store still or moving (video) image information on film, video tape, or other media. Digital cameras capture image information in digital format and store the image information in memory, such as a flash memory, or on other digital storage media. The digital image information can be downloaded to a host system, such as a personal computer. The image information can then be manipulated by rotating the image, cropping the image, or otherwise altering the image with software applications residing on the host system.

The imaging device includes firmware that allows the imaging device to communicate with software on the host system. The firmware includes instructions for performing various functions. For example, the firmware may be used to determine the exposure of an image, sense color in a particular manner, compress image data, conserve power, perform self tests, and/or specify accessing and formatting protocols to the storage medium on the camera.

Oftentimes, it is desirable to upgrade either the host software and/or the camera firmware with a new release of software or firmware. A common method for upgrading software is through the use of a patch, or service pack

upgrade. This method consists of distributing a set of programs via floppy disk, CD-ROM, or World Wide Web to the host machine. The service pack, when run, modifies the components of the host software that need updating.

Updating the firmware is more problematic. This process is typically performed manually by a user. It may involve running an executable program, then resetting the imaging device. Manual updating of the firmware is inconvenient, and may lead to errors caused by incompatible versions of firmware and host system software.

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SUMMARY OF THE PRESENT INVENTION

A method of updating firmware on an imaging device coupled to a host system is disclosed. The host system detects that the firmware on the imaging device is incompatible with a configuration of the host system. In response to detecting the incompatibility, an updated firmware image is transferred from the host system to the imaging device. In one embodiment, the updated firmware image is an older version of firmware than the one that is replaced.

Other features, and advantages of the present invention will be apparent from the accompanying drawings and from the detailed description that follows below.

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a representation of an imaging device that is attachable to a host system.

Figure 2 shows one embodiment of the flow of information among the components of the host system when the imaging device 10 is first connected to the host system 20.

Figure 3 shows one embodiment of the flow of information among the components of the host system after the host application software 60 has been initiated.

Figure 4 shows one embodiment of the polling initialization process.

Figure 5 shows an embodiment of the polling process between the camera API 62 and the host applications software 60.

Figure 6 shows a flowchart of one embodiment of the process of checking whether a compatible imaging device is connected to the host system.

Figure 7 shows a flowchart of one embodiment of updating the firmware.

Figure 8 shows one embodiment of a state transition diagram of the firmware boot process.

Figure 9 shows a diagram of an exemplary nonvolatile memory 400 which stores the firmware.

Figure 10 shows a flowchart of one embodiment of the process of initializing the host application software to establish a communication with a camera.

Figure 11 shows a flowchart of one embodiment of the process of detecting that an imaging device such as a camera is attached to a host system.

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DETAILED DESCRIPTION

A method of updating firmware between an imaging device and a host system is disclosed. The firmware includes instructions which are used to control an embedded system, such as an imaging device. In one embodiment, the firmware update is performed automatically upon connecting the imaging device to the host system. This simplifies operation for the user while ensuring compatibility between the imaging device and the host software. The firmware update may provide "bug" fixes, enhancements to algorithms, updated color sensing, updated compression, new protocols for accessing and formatting the storage medium, and so forth. As will become clear, the automatic firmware update is particularly useful when multiple imaging devices with different versions of firmware are used with host systems that have different versions of software.

The following description describes the firmware update in the context of a system that transfers image information between the image device and the host system automatically upon coupling the image device to the host system. However, the firmware update is not limited to such a system.

The imaging device may be an image capture device, such as a camera. Alternatively, the techniques disclosed can be used with any device that is capable of storing image information. The host system may be any system which is capable of manipulating image information. For example, the host system may be a personal computer such as an IBM-compatible personal computer running on an Intel Pentium® or Pentium® II processor. However, the host system could alternatively be a printer, plotter, fax machine, display device, or storage device.

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For purposes of clarity, the following description is written in terms of the imaging capture device being a camera and the host system being a computer. It should be understood that other imaging devices and host systems may be employed.

Figure 1 shows a representation of an imaging device 10 that is attachable to a host system 20. In one embodiment, the imaging device 10 is attached via a cable 22 to a port 26 of the host system 20. The imaging device 10 is preferably coupled to the host system 20 using a data transfer protocol that supports a high data transfer rate. In one embodiment, the imaging device 10 is coupled to the host system 20 via a Universal Serial Bus (USB) connection. The USB connection provides for a data transfer rate of up to 12 Mb/s. Other connections and data transfer protocols may alternatively be used, such as the 1394 protocol. (More information on USB can be obtained from the World Wide Web at the URL http://www.usb.org/. The 1394 standard is maintained and distributed by the Institute of Electrical and Electronic Engineers. Firewire, one implementation of 1394, is defined by IEEE Standard 1394-1995.)

Figures 2 and 3 are embodiments showing the relationship and messaging between components of the host system 20 and imaging device (camera) 10. Figure 2 shows one embodiment of the flow of information among the components of the host system when the imaging device 10 is first connected to the host system 20. The host system 20 includes an operating system (O/S) 40 and host application software 60. The host system 20 detects when an imaging device such as a camera 10 is attached to the host system 20. In one embodiment, the operating system 40 detects whether a camera 10 is attached to the system by polling the port 26. A port driver 42 may be used to

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provide an interface between the operating system 40 and the port 26. In one embodiment, the port 26 is a USB port and the port driver is a USB driver.

The operating system may be one of a variety of different operating systems. In one embodiment, the operating system is a Windows* operating system, such as Windows* 95, or Windows* 98 made by Microsoft Corporation. Windows 98 includes hooks which allow the polling of ports. Other operating systems may be modified to provide for such polling. The polling is preferably performed in the background so that the user need not be aware that it is being performed. Alternatively, host application software 60 can perform the polling of the port 26. However, polling by the operating system 40 (instead of by host application software 60) has a performance advantage, since the operating system is already set up for polling various activities, such as keyboard pushes, mouse movements, and so forth. For the purposes of illustration, the following description assumes that the operating system does the polling. A person skilled in the art can make the modifications to allow an application to do the polling.

When a camera 10 is connected to the port 26 of the host system 20, the port driver 42 signals the operating system 40 that the camera has been attached to the host system 20. This is illustrated by the arrow marked (1) shown in Figure 1. The operating system 40 identifies the device as a camera and loads the corresponding software driver 44 into memory as illustrated by the arrow (2). In one embodiment, the operating system 40 interrogates the camera 10 to get an identifier. The operating system 40 loads the software driver 44

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corresponding to the identifier. In this example, a camera driver 44 is loaded by the operating system 40.

The operating system 40 then loads one or more software applications corresponding to the camera. In one embodiment, the operating system allows software applications to be registered. Upon meeting a predetermined condition (such as a camera with a particular identifier being detected), the registered host application software is loaded. In this case, the host application software 60 (for the camera) is loaded as shown by the arrow (3). In one embodiment, the camera driver 44 signals the operating system 40 to initiate the host application software 60. The host application software 60 initiates the transfer of image information between the image device (camera) 10 and the host system 20. The host application software 60 may also process images. For example, the host application software 60 can perform decompression and/or color correction on the images. Furthermore, the host application software 60 may perform rotation, cropping, and other image manipulation functions.

Some operating systems, such as Windows 98 allow specific events to cause software applications to be launched. For example, the camera driver 44 can be set up with registered events such as "connection detected with camera" or "shutter button on camera is pushed." Thus, an operating system can be set up to automatically launch an application such as the host application software 60 when the camera 10 is attached.

In one embodiment, if the camera driver 44 or the host application software 60 is not installed on the host system 20 when the camera 10 is attached to the host system 20, then the user is requested to provide the camera driver 44 and/or host application software 60 for the device that has been

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attached to the port 26. Once the installation has been completed, the process proceeds as previously described.

Figure 3 shows one embodiment of the flow of information among the components of the host system after the host application software 60 has been initiated. In this embodiment, after being loaded, the host application software 60 creates and initializes a camera Applications Programming Interface (API) 62 as indicated by arrow (4). The camera API 62 may perform its task in a background thread. In this manner, the host application software 60 need not wait for the camera API 62 to complete before performing other tasks. In one embodiment, the camera API 62 is a COM object which loads a dynamic link library (DLL) 64 as shown by arrows (5). The DLL may be O/W dependent. The camera API 62 communicates to the operating system 40 via the DLL 64. (In another embodiment, the camera API 62 incorporates the DLL 64.) The operating system 40 in turn communicates with the camera 10 via the camera driver 44 and the port driver 42 as shown by arrows (6).

Figure 4 shows one embodiment of the polling initialization process. The polling initialization process begins with the operating system opening the host application software. The host application software 60 then creates and initializes a camera API 62. In one embodiment, the host application software 60 adds itself to the camera API's callback list, so that the host application software 60 will be notified when the camera API is successful in the polling process.

In one embodiment, the camera API upon initialization resets its internal variables, loads a DLL, and creates and starts a background thread. The camera API then inserts a message into the background threaded queue that tries to

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open the camera driver. (A driver is "opened" by establishing a connection between the camera API and the driver.) In one embodiment, the camera driver is only opened when a camera is attached: If the camera driver cannot be opened, then a camera is not attached to the host system. If a camera driver can be opened, then a camera is attached. In one embodiment, the camera API 44 attempts to open the camera driver every half a second.

Figure 5 shows an embodiment of the polling process between the camera API 62 and the host application software 60. In this embodiment, the camera API 62 attempts to open the camera driver (CM_SIGNAL_STATUS). When it is successful at opening the camera driver, the camera API closes the camera driver, and notifies the applications in its callback queue. Since the host application software 60 is in the callback queue of the camera API, it is notified that a camera has been detected.

In this embodiment, the host application software 60 re-opens the camera driver 44 by signaling the camera API 62 to open the camera driver 44 and check for a compatible camera (CM_OPEN_DRIVER). The host application software 60 can then send various commands to the camera 10 via the camera API 62 (and the operating system 40 and drivers 44 and 42). For example, the host application software 60 can request the number of images stored in the camera (CM_GET_NO_OF_IMAGES). The host application software 60 can request a list of the names of the images and the image sizes (CM_GET_IMAGE_LIST), or it can request a particular image (CM_GET_IMAGE_BY_NAME).

In one embodiment, the camera API 62 checks whether a compatible imaging device is connected to the host system, and automatically updates the

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firmware on the imaging device, if necessary. The automatic firmware update may be disabled or enabled as a factory setting by the manufacturer, or it may be alterable by the user.

Figure 6 shows a flowchart of one embodiment of the process of checking whether a compatible imaging device is connected to the host system. In one embodiment, this process is performed by the camera API 62. As previously mentioned, the camera API 62 is created and initialized by the host application software 60 as shown at block 100. The camera API 62 loads a DLL that may be operating system dependent at block 102, and the host application software 60 issues an open command to the camera API 62 at block 104. The camera API in response, opens the camera driver 62 via the DLL 64, as shown in block 106.

At block 108, the camera API 62 issues a command to the camera to fetch the camera interface number. In one embodiment, a unique camera interface number is assigned to a set of commands that the camera supports.

Operation continues at decision block 110. The interface number from the camera is compared with an interface table in the camera API 62. If the interface number is not stored in the camera API 62 interface table, then the camera API 62 closes the camera driver and signals to the host application software that the camera is incompatible, as shown at blocks 112 and 114. The camera API is not able to communicate with the camera because the commands that the camera supports is not known.

At block 110, if the interface number from the camera is stored in the interface table of the camera API 62, then the camera API 62 issues a command to the camera to fetch a hardware version number, as shown at block 120.

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At block 130, the hardware version number from the camera is compared with a hardware table stored in the camera API 62. If the hardware version number from the camera is not stored in the hardware table of the camera API 62, then the camera API 62 is unable to check for an update. The camera API 62 signals the host application software that the camera is open for access, as shown at block 132. The camera API 62 is able to communicate with the camera because its interface is compatible, but it does not update the firmware because it does not recognize the hardware configuration.

At block 130, if the hardware version number from the camera is stored in the hardware table of the camera API 62, then operation proceeds to block 140. At block 140, the camera API issues a command to the camera to return the firmware version number.

Operation proceeds to block 150. If the firmware version number is not different than that stored within the camera API 62, then the camera has updated firmware already. The camera API 62 signals the host application software that the camera is open for access.

If the firmware version number is different than that stored in the camera API 62, then operation continues at block 160. If the manufacturer has disabled the firmware updates, then the camera API 62 does not perform a firmware update and signals the host application software that the camera is open for access. For example, the manufacturer may set a bit in a register of the camera disabling firmware updates. Although the installed firmware may not be the latest version, the installed firmware is still able to perform with the host software as long as the interface and hardware are compatible.

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At block 170, a check is made whether the update has been tried before and failed. In one embodiment, a predetermined number of update tries is performed. If the update has been tried before and failed, then the camera API 62 signals to the host application software that the upgrade failed, and that the camera is open for access, as shown at block 172.

At block 170, if the update has not been tried before, then the flowchart proceeds with the firmware update process, as shown in Figure 7.

Figure 7 shows a flowchart of one embodiment of updating the firmware. At block 200, the camera API transfers an updated firmware image to the camera. In one embodiment, the camera API sends a download firmware command to the camera, so that the firmware will be ready to receive a new firmware image. The updated firmware image is then transferred from the host system to the camera. In one embodiment, the updated firmware image is stored on the camera in a temporary buffer, such as volatile memory.

At block 202, the camera API 62 closes the camera driver. This shuts down communication between the camera and the host system so that the firmware update is not interrupted. The camera API then signals the host application software that it is in the process of updating the firmware, as shown at block 204. The camera API begins to poll for the firmware to re-establish a connection with it.

The firmware is made up of a boot block and a code block. The boot block, also called the bootloader, is not replaced when the firmware is replaced. Only the code block is replaced. The bootloader maintains the routine for updating the firmware. At block 206, the bootloader validates that the updated firmware image is error free. This can be performed by generating a checksum,

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for example. The bootloader then substitutes the updated firmware image for the old (installed) firmware, as shown at block 208. In one embodiment, this is performed by transferring the firmware image from volatile memory into nonvolatile memory. The bootloader then either causes a reset, or it jumps to the start of the bootloader to initiate the newly updated firmware, as shown at block 210. This causes the bootloader to restart, at which point the bootloader checks for errors in the updated firmware, as shown at block 212. If the checksum is correct, then the firmware in the code block is executed, as shown at block 214 and 218.

If the checksum is incorrect, the bootloader re-establishes a connection with the host system and moves to a waiting state, as shown at block 216. In this waiting state, the camera API may get status from the bootloader to determine whether the new firmware image was loaded properly into the code block, or whether there was a problem, and the bootloader is in the waiting state. The camera API may attempt another update of the firmware.

Proceeding from block 218, once the firmware is able to restart with a correct checksum on its code block, then the firmware can establish a connection with the host system. The camera API will detect from its polling that the camera is connected at block 220. The camera API can then re-open the camera driver and perform accesses to the camera.

Figure 8 shows one embodiment of a state transition diagram of the firmware boot process. The state transition diagram is divided into boot block states on the left hand side of the Figure 8 and a code block state on the right hand side of Figure 8. At state 300, a reset initializes the camera hardware. This may include resetting registers and/or turning off certain units of the

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camera, so that the camera is in a known state. From state 300, there is a transition to state 302, at which the code block is checked. In one embodiment, a checksum is performed on the code block. If the checksum passes, then the instructions in the code block are executed, as shown at state 304. The firmware in the code block is able to establish a connection with the host system and handles various commands received from the host system. If the firmware in the code block detects that the host system has issued a download command, then the state transitions to state 306, at which the camera hardware is initialized into a known state. For example, the sensor and strobe may be turned off, and the DRAM may be turned on. In one embodiment, the camera hardware is turned off when not in use in order to save power. The state transitions to block 308, at which the updated firmware code is received from the host system. The updated firmware code is temporarily stored in DRAM in one embodiment

If there is a communication problem at state 308, then there is a transition to waiting state 310. At waiting state 310, the boot block waits for a command from the host system.

From state 302, if the checksum fails, then there is also a transition to waiting state 310. At waiting state 310, the boot block waits for a command from the host system. The host system, for example, may request status information from the boot block. When the host system realizes that the boot block is in waiting state 310, the host system can issue another download command, which results in a transition back to state 308.

From state 308, if the firmware image is downloaded without errors, then there is a transition to state 320, at which the code that was downloaded is

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checked for errors. In one embodiment a checksum is performed. If the checksum fails, then the boot block returns to waiting state 310. If the checksum passes, then the state transitions to block 322, at which the code block is erased. Subsequently, the code block is re-programmed in state 324. From state 324, there is a transition back to state 300 at which the camera hardware is re-initialized and the state transition diagram restarts as previously described.

Figure 9 shows a diagram of an exemplary nonvolatile memory 400. In one embodiment, the nonvolatile memory is a flash memory. In one embodiment, the boot block 402 and code block 404 are stored in the flash memory, and the boot block is locked so that it is not overwritten. The code block is re-programmable.

In one embodiment, the nonvolatile memory also stores one or more imaging tables 406. The imaging tables may include information associated with the configuration of the camera.

In one embodiment, the following imaging tables are stored in the flash memory.

1) dead pixel table

2) encoder table

3) exposure table

4) compander table

5) color correction tables

The imaging tables allow for processing of an image in the camera. For example, the dead pixel table may include information on particular pixels of the camera which do not work properly. The dead pixel table may be

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determined during manufacturing testing, for example. Alternatively, a camera may be able to determine dead pixels dynamically. The dead pixel table allows for interpolation using neighboring pixels to compensate for the defective pixels.

Similarly, the other imaging tables allow manipulation of imaging data. For example, the encoder table may specify particular values used for encoding or compressing an image. Exposure tables may include information on exposure time, gain, strobe use and intensity. The companding table may include information used to map data from a bit representation using a first number of bits to a bit representation using a smaller number of bits. The color correction tables may be used to correct colors.

In one embodiment, the imaging tables include values that are associated with a particular illuminant. For example, the imaging tables may include different values corresponding to the capture of an image in either sunlight, fluorescent lighting, or tungsten bulb lighting.

The imaging tables may be stored into the nonvolatile memory 400 during manufacturing, but may be updated later by the firmware. In one embodiment, the firmware is able to delete imaging tables in the nonvolatile memory and transfer new imaging tables from the host system to the nonvolatile memory of the camera. The firmware receives commands from the host system which indicates whether a table is to be transferred to the camera, or whether an imaging table is to be deleted.

In one embodiment, because some nonvolatile memories (e.g., some flash memories) are not able to both read from the nonvolatile memory and write to the nonvolatile memory at the same time, a DRAM is used to

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temporarily store code from the nonvolatile memory. The firmware copies a portion of its code to the DRAM, then transfers execution to the DRAM. A microcontrolller executing instructions out of the DRAM is able to then write the new imaging tables to the nonvolatile memory. Execution is subsequently transferred back to the code section of the nonvolatile memory.

Tables 1 and 2 are used to show examples of how various versions of interfaces, firmware, and camera APIs on different cameras and personal computers (PCs) may interrelate. Table 1 indicates a configuration table stored in a first camera API (CAMAPI #400). Table 2 indicates a configuration table stored in a second camera API (CAMAPI #420). Some examples of various embodiments using the configuration information stored in these tables will help to illustrate.

Table 1.

Interface Identifier	Hardware Version	Firmware Version/ Firmware Image
0x0101	1.00	1.00/Filename 3
	1.01	1.02/Filename 4
	1.02	1.07/Filename 5
0x0202	2.00	1.08/Filename 6

Table 2.

Interface Identifier	Hardware Version	Firmware Version
0x0303	3.00	1.09/Filename 8
	3.01	1.09/Filename 8

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	3.02	2.18/Filename 12
0x0404	4.00	3.08/Filename 13

Example 1: Assume that two users, A and B, have the same version of host application software and firmware versions. Let the software version be 1.0 which creates CAMAPI #400 having the table of identifiers shown in Table 1. The interface identifier is 0x0101, and the firmware version is 1.00. Next, user A receives an upgrade and updates his host application software to version 1.02, which has the same interface (0x0101).

After the host application software is upgraded, the first time that user A tries to access the camera, the camera API 62 will detect an incompatible version of firmware. It will trigger the firmware to be updated automatically, as was previously described.

Subsequently, assume that user B (who still has firmware version 1.00 on his camera) brings his camera to A's PC and plugs it in. The camera API on A's PC will again detect the firmware and software versions. The camera API will update the firmware on B's camera to 1.02. B's camera will now have a different firmware (1.02) than the host software on B's PC. When B takes his camera back to B's PC, the camera API 62 will have no knowledge of the firmware version 1.02. The camera API 62 will transfer the firmware image version 1.00 to B's camera. Thus, B's camera is restored to its original firmware so that it can communicate with the software on B's PC.

The firmware update is transparent to B. B is able to use his camera on either A's updated system or B's system with older host application software.

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Example 2: Assume that A has firmware version 1.00, interface 0x0101, and B has firmware version 1.08, interface 0x0202. B cannot use A's PC unless A upgrades her software to recognize the new interface 0x0202. If B's PC uses the camera API including all revisions shown in Table 1, then B's PC can be used with either A's camera or B's camera.

Example 3: If user A has firmware version 1.0 and uses CAMAPI #400 as shown in Table 1, and user B has firmware version 3.0 and uses CAMAPI #420, as shown in Table 2, then a PC must have both versions of software that interface with the separate interfaces to the cameras in order to access both cameras.

In one embodiment, the interfaces have unique interface identifiers. One example of an interface is the TWAIN interface, which describes to an imaging application how to go about acquiring images from a scanner or other digital imaging devices. The current version of TWAIN is 1.7. TWAIN is maintained by a standards group made up of several industry participants. More information on TWAIN is available through http://www.twain.org. Proprietary interfaces may also be used. For example, DLLs supporting a particular application program so that the application program has the ability to transfer and delete images from the imaging device may be supported.

The hardware identifier specifies hardware changes, for example, a stepper motor may be added to the imaging device. Firmware releases may be set up to track minor and major changes. For example, a minor change may be a bug fix or enhancement. A major change may be the addition of new hardware.

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Figure 10 shows a flowchart of one embodiment of the process of initializing the host application software to establish a communication with an imaging device. In this disclosed embodiment, the imaging device is a camera, and the host system is a personal computer. The flowchart begins at block 500. The process continues at block 502, at which the host application software creates a camera API. The camera API loads a DLL that may be operating system dependent at block 504. At block 506, the camera API determines if a camera is available.

At block 508, if a camera is not available, then the flowchart returns to block 506. However, if a camera is available, the process continues at block 510. At block 510, the camera API sends a message to the host application software indicating that a camera is available. The host application software requests that the camera driver be open at block 512. The camera API responds by opening the camera driver, as shown at block 514. The process of opening a driver means establishing a connection between the camera API and the camera driver. The firmware update process, as previously described, occurs at this point.

At block 516, the host application software requests that images are transferred from the camera to the host system. The camera API responds by transferring image information from the camera to the host application software at block 518. Image information may include image pixel data as well as other information, such as color palette information, compression information, orientation of the image, and so forth. The flowchart terminates at block 520.

Figure 11 shows a flowchart of one embodiment of the process of detecting that an imaging device such as a camera is attached to a host system.

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The flowchart starts at block 600. It continues at block 602, in which the operating system determines if a camera is available. This may be done with the aid of a port driver such as a USB driver. If the camera is not available, the process returns to block 602. If a camera is available at block 604, the process continues at block 606 at which the operating system loads the camera driver.

In one embodiment, an operating system such as Windows 98 is used by the host system. Windows 98 allows the driver to signal the operating system of the camera being connected to the host system (the connection event), as shown by block 608. The operating system then opens the applications that are registered with the connection event. In this case, the host application software for the camera is initiated, as shown at block 610. The flowchart then continues with the flowchart of Figure 10.

If the operating system does not provide a way of opening an application based on the connection event, an alternate embodiment may use a "service" instead of the steps shown by blocks 608 and 610. The service is installed by the user and is initiated on the host system automatically when the host system boots up. The service opens the host application software when a camera is detected. In one embodiment, the service uses the camera API to determine if the camera is available. Thus, the service acts as a mini-host application in a manner similar to that shown in Figure 10. However, the service initiates the host application software when a connection to the camera driver is established. The host application then establishes its own connection to the camera driver to transfer images from the camera.

In one embodiment, the host application software 60 and the camera driver 44 are shipped with the camera 10. The host application software 60 and

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camera driver 44 may be shipped via floppy disk or CD-ROM. Alternatively, the host application software 60 and camera driver 44 can be downloaded via the World Wide Web. The host application software 60 and camera driver 44 are installed to a storage medium on the host system, such as a hard disk, dynamic random access memory (DRAM), static random access memory (SRAM), or flash memory.

In the foregoing specification, the invention has been described with reference to specific exemplary embodiments thereof. It will, however be evident to someone having the benefit of this disclosure, that various modifications and changes may be made thereto without departing from the broader spirit and scope of the invention as set forth in the appended claims. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.

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CLAIMS

WHAT IS CLAIMED IS:

1. A method of updating firmware on an imaging device coupled to a host system, the method comprising the steps of:

(a) detecting that the firmware on the imaging device is incompatible with a configuration of the host system; and

(b) transferring an updated firmware image from the host system to the imaging device in response to the step (a).

2. The method of claim 1, wherein the step (a) further comprises the steps of:

(i) getting device interface information from the imaging device; and

(ii) comparing the device interface information with interface information stored on the host system.

3. The method of claim 1, wherein the step (a) is performed automatically upon establishing a connection between the imaging device and the host system.

4. The method of claim 1, wherein the step (b) further comprises the steps of:

(i) transferring the updated firmware image to a buffer memory;

(ii) checking for errors in the buffer memory; and

(iii) substituting the buffer memory for the incompatible firmware on the imaging device.

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5. The method of claim 1, wherein the updated firmware image of the step (b) corresponds to an earlier version of firmware than that detected on the imaging device in the step (a).

6. The method of claim 1, wherein the step (b) further comprises the step of:

(i) loading one or more configuration tables into the imaging device from the host system.

7. The method of claim 6, wherein the one or more configuration tables are used to manipulate imaging data on the imaging device.

8. A system comprising:

a processor;

a storage medium storing instructions which when executed by the processor cause the processor to perform the steps of:

(a) detecting that firmware on an imaging device is out of date with a configuration of the system; and

(b) transferring an updated firmware image from the system to the imaging device in response to the step (a).

9. The system of claim 8, wherein the step (a) comprises the steps of:

(i) getting device interface information from the imaging device; and

(ii) comparing the device interface information with interface information stored on the system.

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10. The system of claim 8, wherein the step (b) comprises the steps of:

(i) loading one or more configuration tables into the imaging device from the system.

11. The system of claim 10, wherein the one or more configuration tables are used to manipulate imaging data on the imaging device.

12. A computer-readable medium having stored thereon a plurality of instructions which, when executed by a processor, cause the processor to perform the steps of:

(a) detecting that firmware on an imaging device is incompatible with a configuration of a host system; and

(b) updating the firmware automatically in response to the step (a).

13. The computer-readable medium of claim 12, wherein step (a) further comprises the steps of:

(i) getting device interface information from the imaging device; and

(ii) comparing the device interface information with interface information stored on the host system.

14. The computer-readable medium of claim 12, wherein the step (b) further comprises the step of:

(i) loading one or more configuration tables into the imaging device from the host system.

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15. The computer-readable medium of claim 14, wherein the one or more configuration tables are used to manipulate imaging data on the imaging device.

16. A method of updating firmware on a camera, the method comprising the steps of:

(a) connecting the camera to a host system, the host system set up with a configuration;

(b) detecting that firmware on the camera is incompatible with the configuration of the host system; and

(c) updating the firmware automatically in response to the step (b).

17. The method of claim 16, wherein the step (b) further comprises the steps of:

(i) getting device interface information from the camera; and

(ii) comparing the device interface information with interface information stored on the host system.

18. The method of claim 16, wherein the step (c) further comprises the step of:

(i) loading one or more configuration tables into the camera from the host system.

19. The method of claim 18, wherein the one or more configuration tables are used to manipulate imaging data on the imaging device.

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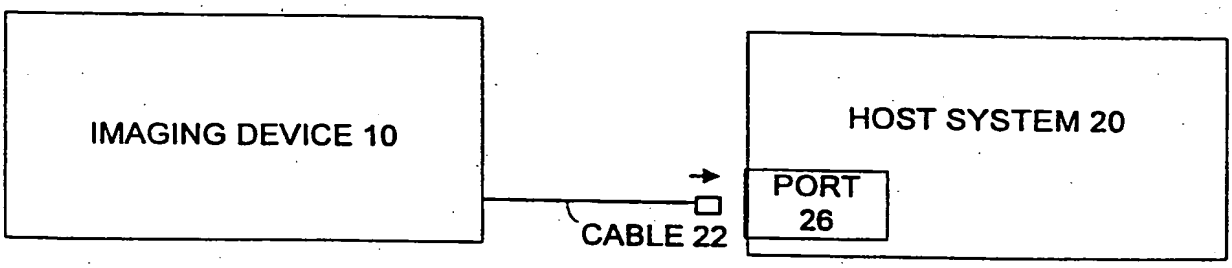

FIG. 1

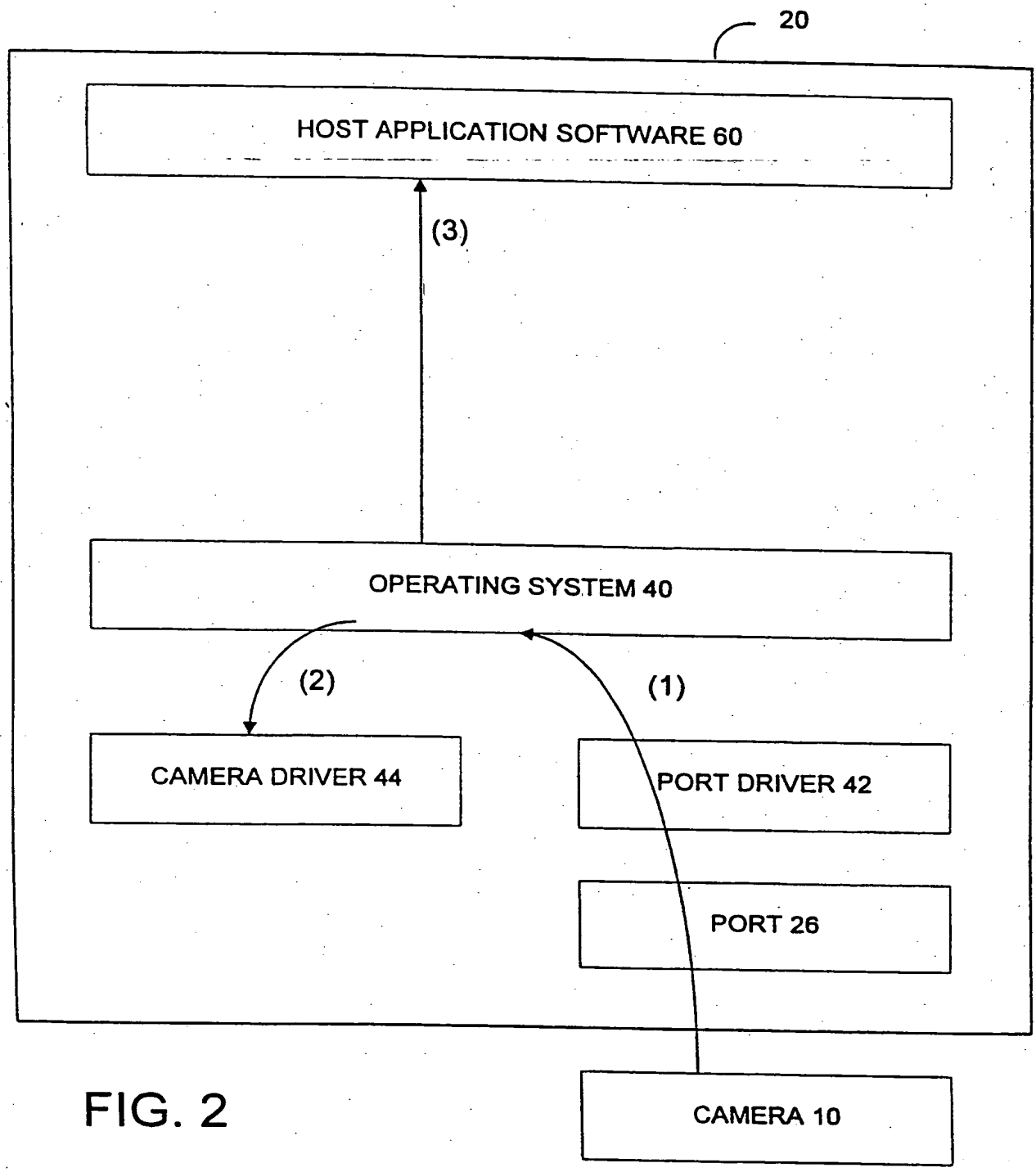
20
HOST APPLICATION SOFTWARE 60
(3)
OPERATING SYSTEM 40
(2)
(1)
CAMERA DRIVER 44
PORT DRIVER 42
PORT 26
CAMERA 10

FIG. 2

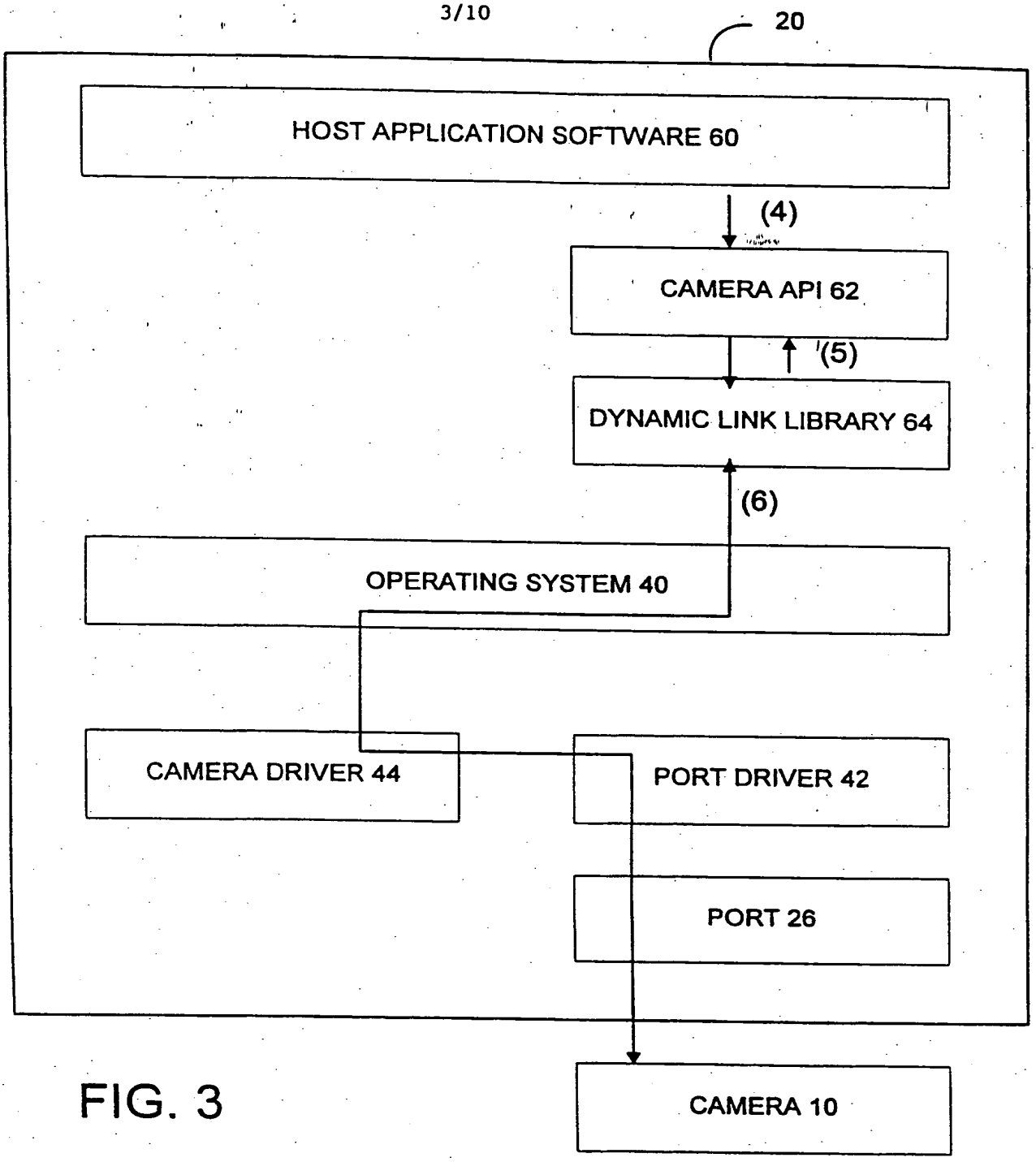
20
HOST APPLICATION SOFTWARE 60
(4)
CAMERA API 62
(5)
DYNAMIC LINK LIBRARY 64
(6)
OPERATING SYSTEM 40
CAMERA DRIVER 44
PORT DRIVER 42
PORT 26
CAMERA 10

FIG. 3

OPERATING SYSTEM	HOST APPLICATION S/W	CAMERA API
Open Host Application S/W →	Create and Initialize CameraAPI →	Reset internal variables
	→	Load DLLs
	→	Create & start backgrd thread
	→	Insert a CM_SIGNAL_STATUS message into backgrd-threaded queue
	Add main window to CameraAPI's callback list	

FIG. 4

CAMERA API		HOST APPLICATION SOFTWARE
CM_SIGNAL_STATUS		
If Camera is not Open		
If OpenDriver() succeeds		
Close Driver()		
If message has not been sent before		
Signal all callback windows	→	**WM_CAMERAAPI_STATUS**
		If Message is CM_IS_CONNECTED
CM_OPEN_DRIVER	←	OpenDriver()
Open camera driver		
Check for compatible camera		
CM_GET_NO_OF_IMAGES	←	Get number of images
Returns number o f images on camera		
CM_GET_IMAGE_LIST	←	If number of images > 0
Returns list of image names and sizes		Get Image List
CM_GET_IMAGE_BY_NAME	←	Download images, one-by-one
Returns image with given name		

FIG. 5

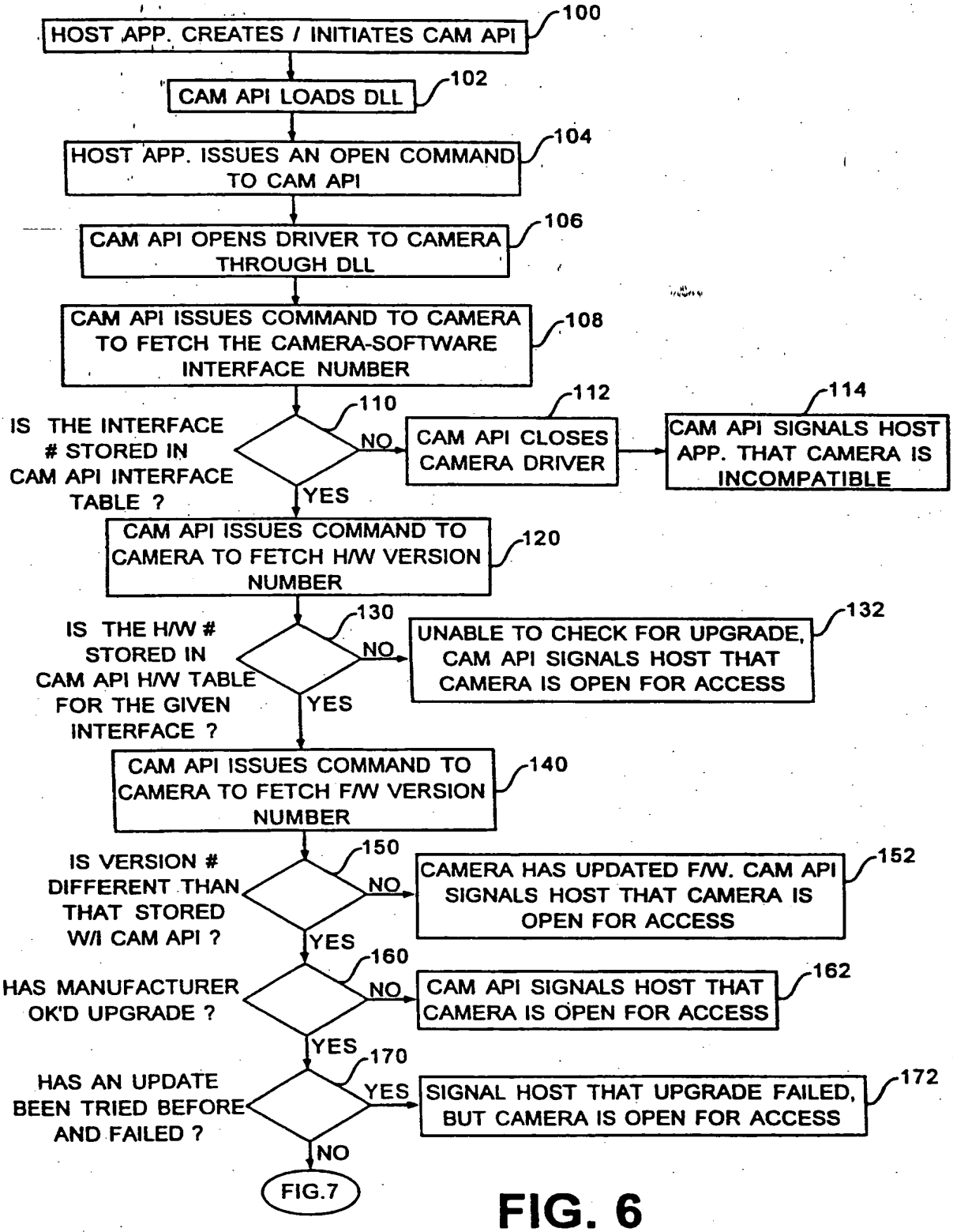

FIG. 6

BNSDOCID: <WO_____9942924A1_I_>

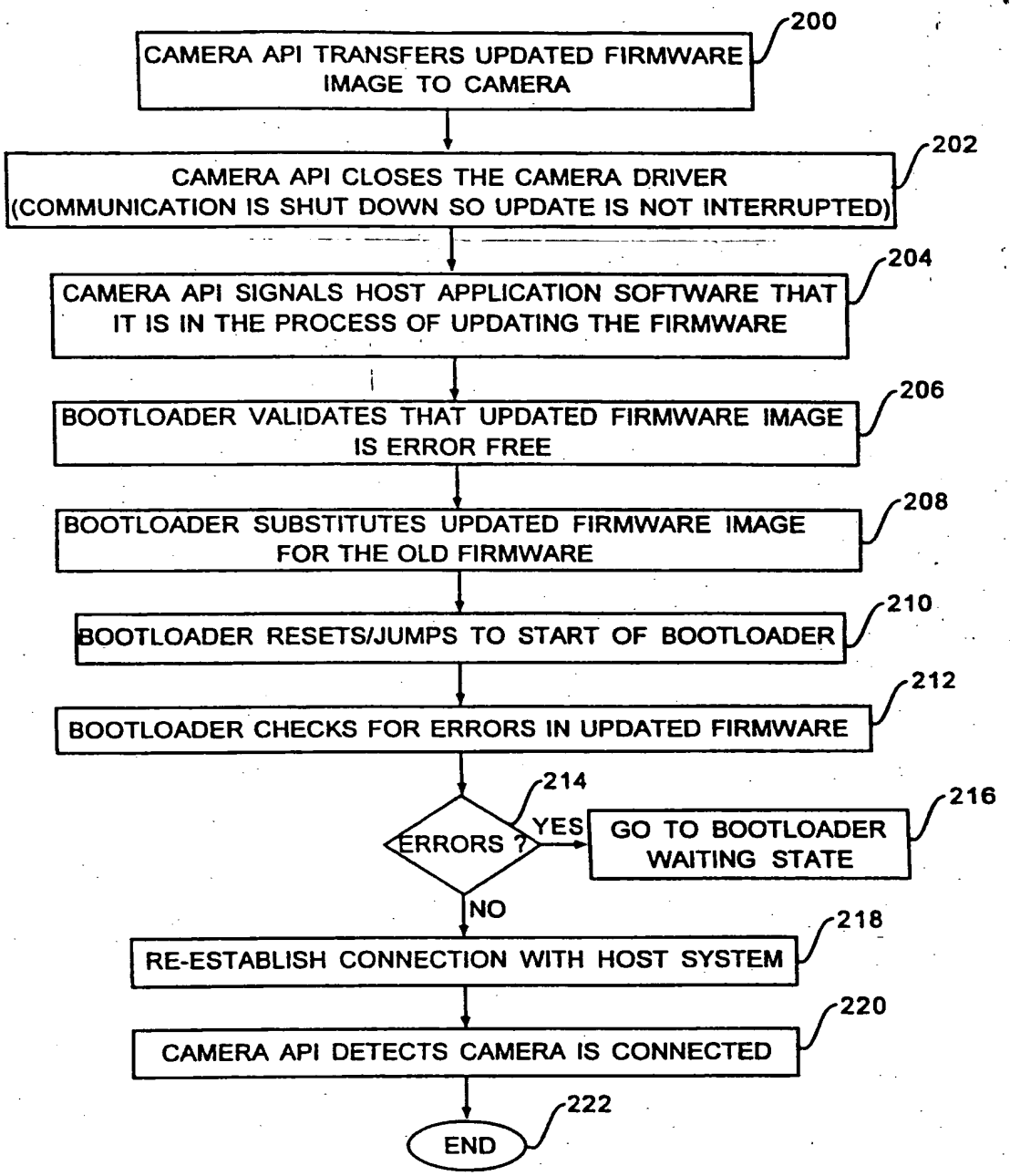

FIG. 7

BNSDOCID: <WO_____9942924A1_I_>

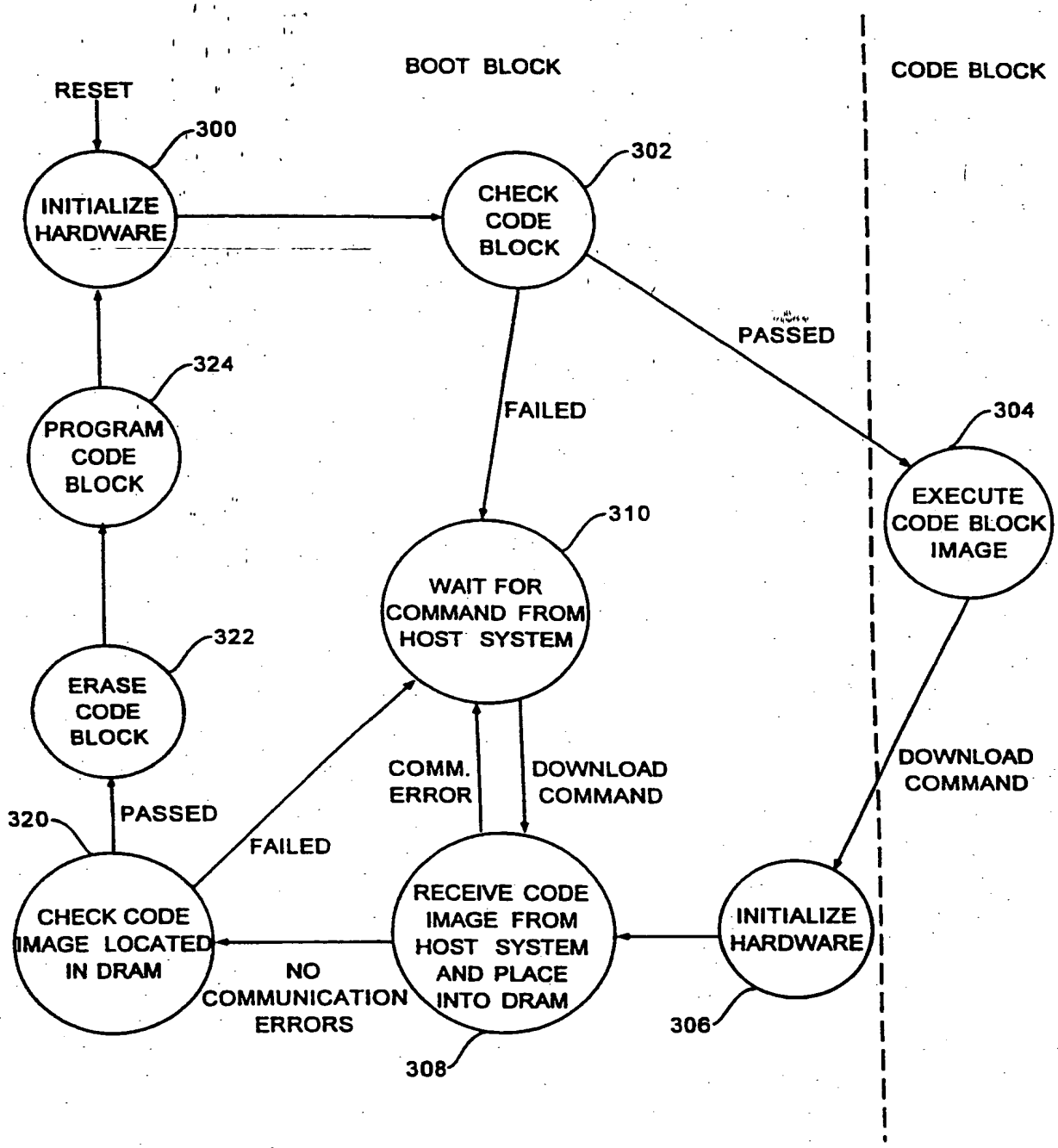

FIG. 8

BNSDOCID: <WO_____9942924A1_I_>

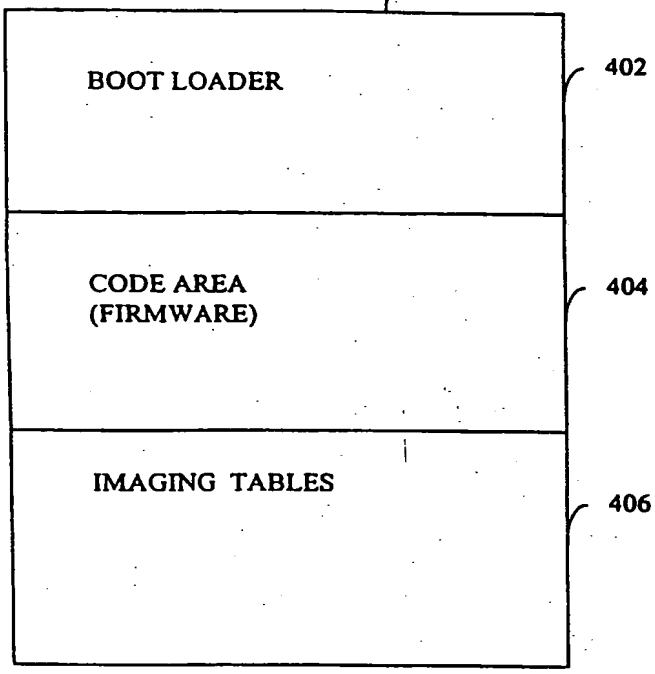
400
BOOT LOADER
402
CODE AREA
(FIRMWARE)
404
IMAGING TABLES
406

FIG. 9

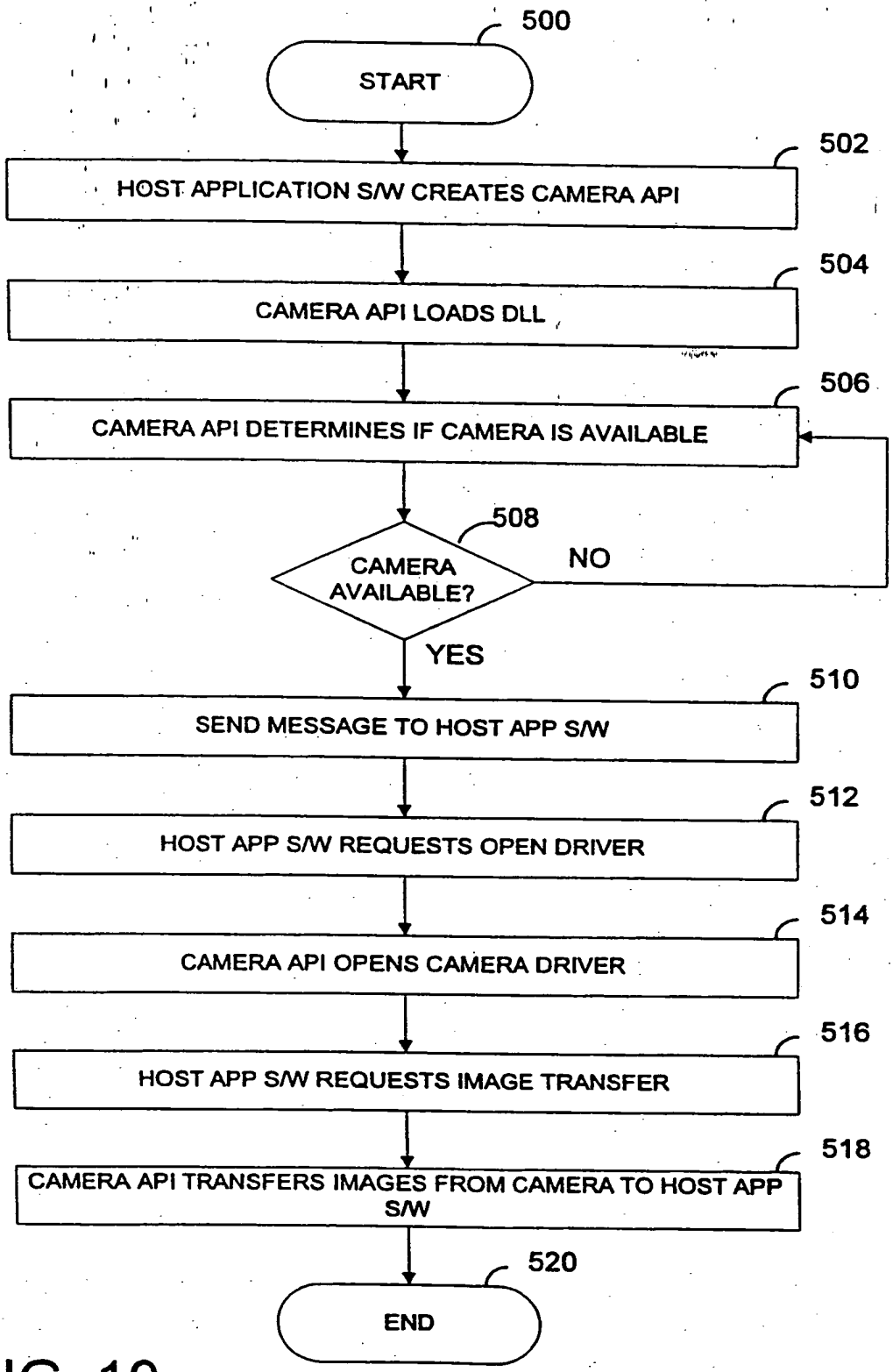
500
START
502
HOST APPLICATION S/W CREATES CAMERA API
504
CAMERA API LOADS DLL
506
CAMERA API DETERMINES IF CAMERA IS AVAILABLE
508
CAMERA AVAILABLE?
NO
YES
510
SEND MESSAGE TO HOST APP S/W
512
HOST APP S/W REQUESTS OPEN DRIVER
514
CAMERA API OPENS CAMERA DRIVER
516
HOST APP S/W REQUESTS IMAGE TRANSFER
518
CAMERA API TRANSFERS IMAGES FROM CAMERA TO HOST APP S/W
520
END

FIG. 10

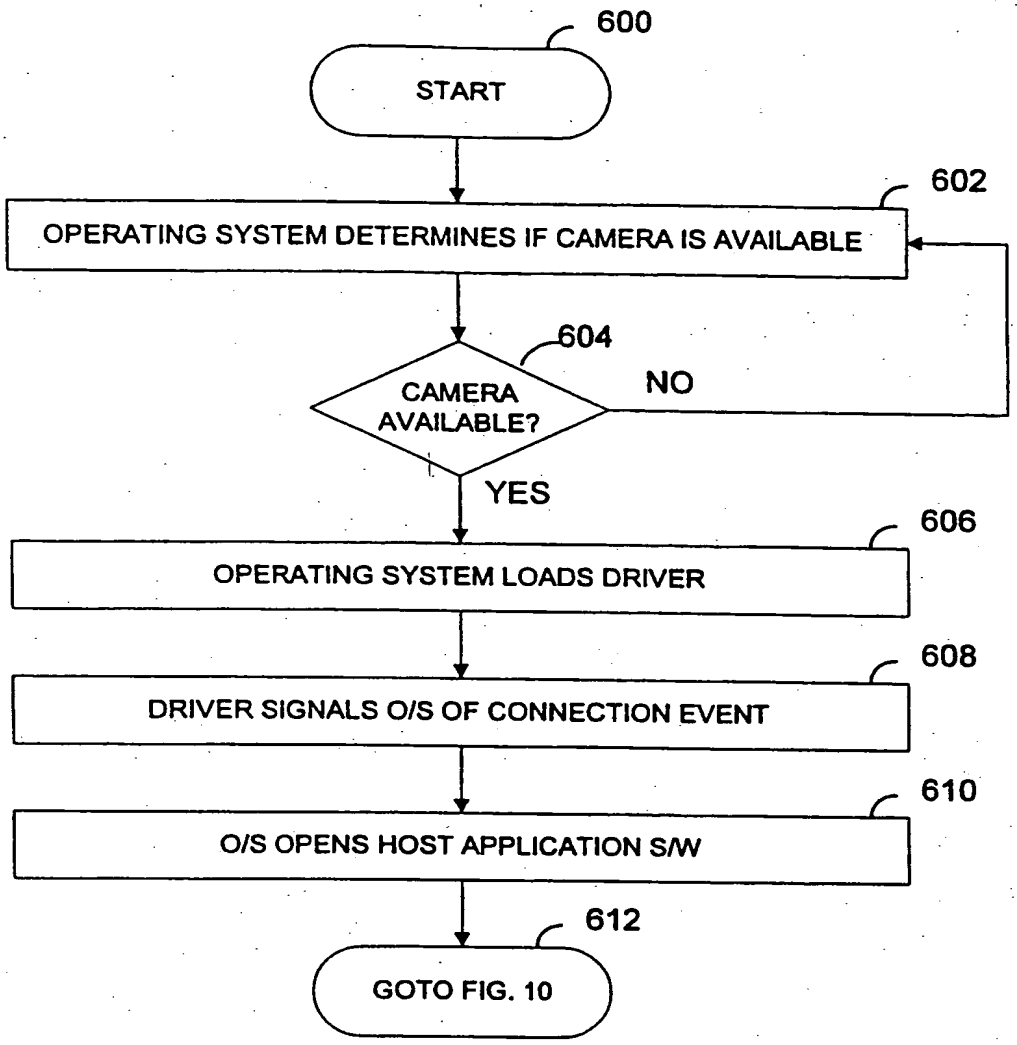
600
START
602
OPERATING SYSTEM DETERMINES IF CAMERA IS AVAILABLE
604
CAMERA AVAILABLE?
NO
YES
606
OPERATING SYSTEM LOADS DRIVER
608
DRIVER SIGNALS O/S OF CONNECTION EVENT
610
O/S OPENS HOST APPLICATION S/W
612
GOTO FIG. 10

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/01398

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) : G06F 9/445
US CL : 395/712
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 395/712

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,477,264 A (SARBADHIKARI et al.) 19 December 1995, See col. 7, ll. 54-59, col. 8, ll. 4-23, col. 7, ll. 51-67, col. 4, ll. 59-63	1-3 and 5-19
Y	US 5,226,145 A (MORONAGA et al.) 06 July 1993, col. 15, ll. 35-37 and col. 16, ll. 37-62	1-3 and 5-19

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
04 MARCH 1999	21 APR 1999
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer Antony Nguyen-Ba Telephone No. (703) 305-0103

Form PCT/ISA/210 (second sheet)(July 1992) ★

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